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SOIL-VEGETATION CORRELATIONS IN COASTAL MISSISSIPPI WETLANDS

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**SOIL-VEGETATION CORRELATIONS IN
COASTAL MISSISSIPPI WETLANDS**

by

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PREFACE

The National Ecology Research Center of the U.S. Fish and Wildlife Service (FWS) is supporting a series of field research studies to document relationships between hydric soils and wetland vegetation in selected wetlands throughout the United States. This study is one of that series. It is a continuation of the FWS effort, begun by Wentworth and Johnson (1986), to develop a procedure using vegetation to designate wetlands based on the indicator status of wetland vegetation as described by the FWS "National List of Plants that Occur in Wetlands" (Reed 1986). This list classifies vascular plants of the U.S. into one of five categories according to their natural frequency of occurrence in wetlands. Concurrent with the development of the wetland plant list, the Soil Conservation Service (SCS) developed the "National List of Hydric Soils" (SCS 1985). Studies supported by the National Ecology Research Center quantitatively compare associations of plant species, designated according to their hydric nature using the Wentworth and Johnson (1986) procedure, with the hydric nature of soils according to their designation on the SCS hydric soils list. The studies are being conducted across moisture gradients at a variety of wetland sites throughout the U.S. Several studies have been modified to obtain information on groundwater hydrology.

These studies were conceived in 1984 and implemented in 1985 in response to internal planning efforts of the FWS. They parallel, to some extent, ongoing efforts by the SCS to delineate wetlands for Section 1221 of the Food Security Act of 1985 (the swampbuster provision). The SCS and FWS provided joint guidance and direction in the development of the Wentworth and Johnson (1986) procedure, and the SCS currently is testing a procedure that combines hydric soils and the Wentworth and Johnson procedure for practical wetland delineation. The efforts of both agencies are complimentary and are being conducted in close cooperation.

The primary objectives of these studies are to: (1) assemble a quantitative data base of wetland plant community dominance and codominance for determining the relationship between wetland plants and hydric soils; (2) test various delineation algorithms based on the indicator status of plants against independent measures of hydric character, primarily hydric soils; and (3) test, in some instances, the correlation with groundwater hydrology. The results of these studies also can be used, with little or no supplementary hydrologic information, to compare wetland delineation methods of the Corps of Engineers (1987) and the Environmental Protection Agency (Sipple 1987).

Any questions or suggestions regarding these studies should be directed to: Charles Segelquist, National Ecology Research Center, 2627 Redwing Road, Creekside One, Fort Collins, Colorado, 80526-2899, phone FTS 323-5384 or Commercial (303)266-9384.

CONTENTS

| | <u>Page</u> |
|--|-------------|
| PREFACE | iii |
| TABLES | vi |
| ACKNOWLEDGMENTS | vii |
| INTRODUCTION | 1 |
| DESCRIPTION OF STUDY AREA | 1 |
| METHODS | 3 |
| RESULTS | 6 |
| DISCUSSION | 6 |
| CONCLUSIONS | 22 |
| LITERATURE CITED | 24 |
| APPENDICES | |
| A. Descriptions of soil series | 27 |
| B. Alphabetical listing of scientific names, codes, and National Wetland Plant List ecological indices of plant species identified in wetlands of coastal Mississippi | 30 |
| C. Frequencies of occurrence of species by soil series within vegetation strata | 35 |

TABLES

| <u>Number</u> | | <u>Page</u> |
|---------------|---|-------------|
| 1 | Sampling schemes for vegetation strata..... | 4 |
| 2 | Ecological indices used for weighted, presence/absence, and Michener averages, with definitions of modifiers in the National Wetland Plant Species List (Reed 1986) | 5 |
| 3 | Means, standard errors of means, and ranges for weighted averages for soil series and sampling sites within vegetation strata | 7 |
| 4 | Means, standard errors of means, and ranges for presence/ absence averages by soil series and sampling sites within vegetation strata | 11 |
| 5 | Means, standard errors of means, and ranges for Michener averages by soil series and sampling sites within vegetation strata | 15 |
| 6 | Duncan multiple range tests for weighted averages calculated for soil series within vegetation strata | 19 |
| 7 | Duncan multiple range tests for presence/absence averages calculated for soil series by vegetation strata | 20 |
| 8 | Duncan multiple range tests for Michener averages calculated for soil series by vegetation strata | 21 |

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INTRODUCTION

The U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979:3-4) defines wetlands as lands that are:

... transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.... Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.... The upland limit of a wetland is designated as: (1) the boundary between land with predominantly mesophytic and xerophytic cover; (2) the boundary between soil that is predominantly hydric and soil that is predominantly nonhydric; or (3) in the case of wetlands without vegetation or soil, the boundary between land that is flooded or saturated at some time each year and land that is not.

Hydrophytes, or hydrophytic vegetation, are plants that grow in water or a substrate that is periodically deficient in oxygen during the growing season as a result of excessive water content (Soil Conservation Service 1986). Hydric soils are defined as soils that in an undrained condition are saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Soil Conservation Service 1985). Correlations between vegetation and soil parameters provide means for delineating and managing wetlands within the United States.

Wetlands in southern Mississippi were selected for a study to examine correlations between hydric soils, as defined by the Soil Conservation Service (1985), and hydrophytic vegetation, identified in the National Wetland Plant List (Reed 1986) of the U.S. Fish and Wildlife Service. The objectives of this study were to: (1) assemble a quantitative data base for determining relationships between the U.S. Fish and Wildlife Service National Wetland Plant List (Reed 1986) and the Soil Conservation Service (1985) Hydric Soils List; (2) estimate the extent to which hydric soils supported a prevalence of hydrophytic vegetation as identified by the indicator status of species recorded in the National Wetland Plant List (Reed 1986); and (3) test Wentworth and Johnson (1986) and other wetland delineation methodologies as they pertain to soil-vegetation correlations.

DESCRIPTION OF STUDY AREA

Our study was performed at the Mississippi Sandhill Crane National Wildlife Refuge, Jackson County, Mississippi (Figure 1). Jackson County is located on the Gulf Coastal Plain, with elevations ranging from sea level to 54 m (Dewhurst 1985).

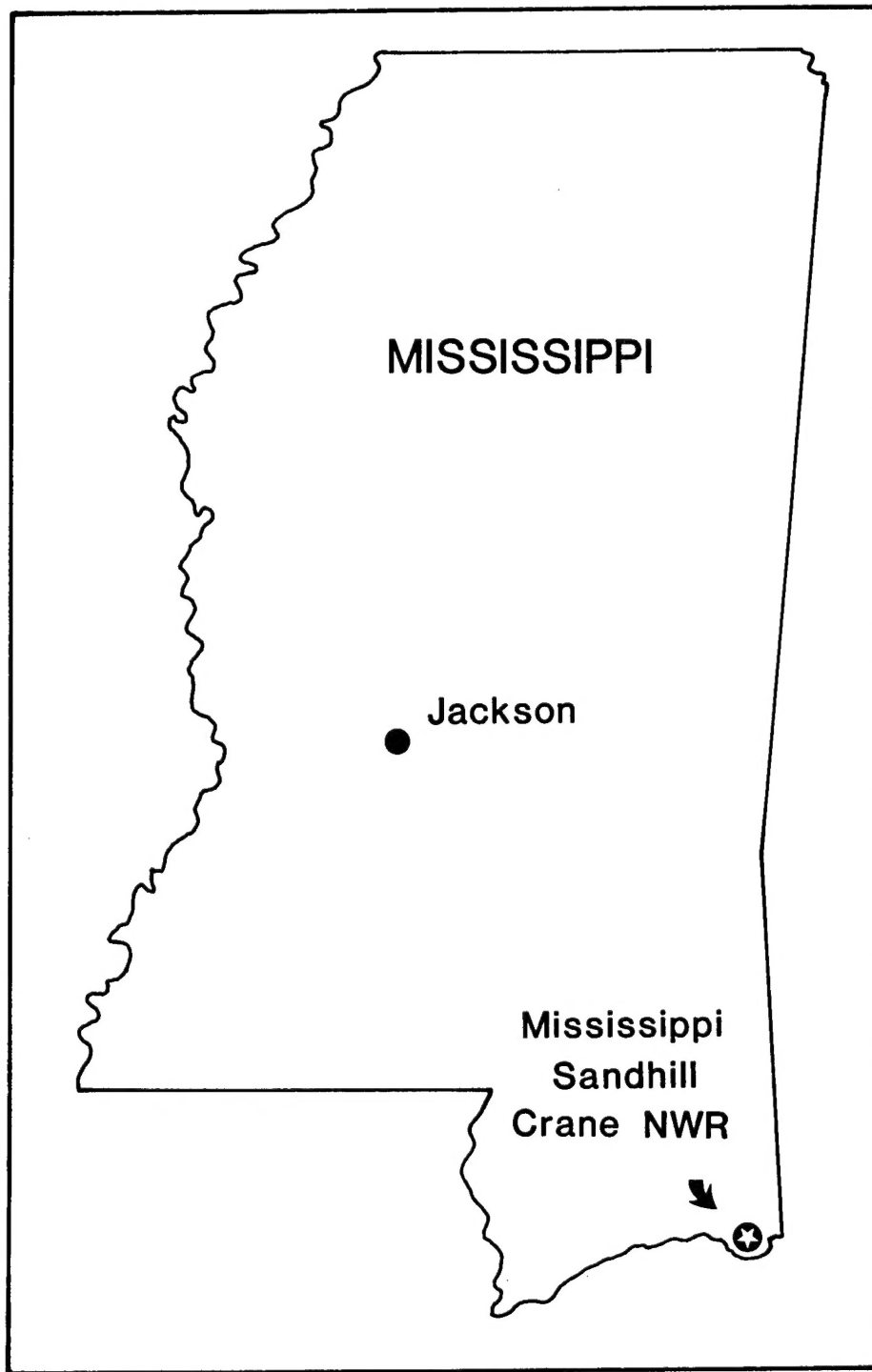


Figure 1. General location of Mississippi Sandhill Crane National Wildlife Refuge.

Timber production is the primary agricultural activity in the county, with field crop production secondary (Cole and Dent 1964). Climate of coastal Mississippi is subtropical and characterized by hot, humid summers. Mean annual precipitation is 184 cm with maximum levels in mid to late summer; mean annual temperature is 20 °C; June through September are hottest, with a mean temperature of 27 °C, and December through February are coldest at 13 °C (Wilson 1987).

The refuge was established in 1975 to provide protection for the endangered Mississippi sandhill crane (*Grus canadensis pulla*), a nonmigratory subspecies, and to preserve unique savanna plant associations (U.S. Fish and Wildlife Service 1987). The refuge contains about 7,290 ha and consists of three separate land tracts (i.e., Gautier, Ocean Springs, and Fontainebleu units) that lie within the nesting range of the Mississippi sandhill cranes. Most soils of the refuge formed under coniferous forest cover, producing strongly acidic, poorly drained loamy soils that are low in organic matter (Dewhurst 1985).

Four main habitat types occur in the refuge: swamps, open savannas (wet prairies), pine (*Pinus* spp.) forests, and tidal marshes. Swamps are composed primarily of woody vegetation, such as blackgum (*Nyssa sylvatica* var. *biflora*), long-leaf pine (*Pinus palustris*), slash pine (*Pinus elliotii*), and bald cypress (*Taxodium distichum*), with a sparse understory dominated by sedges (*Rhynchospora* spp. and *Carex* spp.). Mississippi sandhill cranes rely heavily on savanna habitats for nesting and foraging. Clearing and burning of encroaching woody vegetation are used to maintain herbaceous associations of the savannas; the refuge fire management program prescribes burning about 30% of refuge acreage annually (U.S. Fish and Wildlife Service 1986). Typical species of the savannas include little bluestem (*Schizachyrium scoparium*), toothache grass (*Ctenium aromaticum*), pipeworts (*Eriocaulon compressum* and *E. decangulare*), sedges (*Rhynchospora* spp. and *Scleria* spp.), pitcher plants (*Sarracenia alata* and *S. psittacina*), sundew (*Drosera capillaris*), and composites (*Balduina uniflora*, *Carphephorus pseudoliatris*, and *Helianthus heterophyllus*). Understory associated with pine forests includes wiregrass (*Aristida stricta*) and little bluestem (*Schizachyrium scoparium*).

METHODS

Field work was conducted from mid-September to mid-October 1987 (i.e., during the dry season). Four hydric soil series (i.e., Atmore, Hyde, and Plummer in savannas, and Croatan in swamps) and one nonhydric soil (i.e., Harleston in upland pine forests) were sampled at the refuge to determine whether they supported predominantly hydrophytic vegetation; descriptions of these soils are given in Appendix A. Three hydric soils (Daleville, Hansboro, and Leaf series) were not sampled because they were not well represented at the refuge. Hydric soils initially were identified from the Hydric Soils List of Mississippi (Soil Conservation Service 1985) and the Jackson County Soil Survey (Cole and Dent 1964). All indentifications were confirmed with Tom Kilpatrick, soil scientist, Jackson County Soil Conservation Service.

Four study sites were chosen within each soil series; in general, disturbed sites were not sampled. Five study plots of 100 m² were established randomly at each study site. Vegetation within plots was sampled by strata: trees, large shrubs, small shrubs, and ground cover (Table 1); quadrats for strata were nested within each 100-

Table 1. Sampling schemes for vegetation strata.

| Vegetation strata | Variables measured | Size of quadrats (m ²) | Quadrats per soil series |
|--|---|------------------------------------|--------------------------|
| Ground cover: woody species <0.5 m and all herbaceous species regardless of height | Percent cover | 0.5 | 40 |
| Small shrubs: woody species <1.3 m, >0.5 m | Density - count all plants emerging from ground | 4 | 20 |
| Large shrubs: woody species <7.5 cm dbh, >1.3 m high | Density - count all main leaders | 4 | 20 |
| Trees: all stems >7.5 cm dbh | Density - basal area (from dbh estimates) | 100 | 20 |

m² plot. Plant species were identified in the field whenever possible; unknown species were collected, pressed, and identified later in the laboratory. Botanists Cary Norquist (Office of Endangered Species, U.S. Fish and Wildlife Service, Jackson, MS) and Dr. Sidney McDaniel (Mississippi State University, Starksville, MS) provided assistance with plant identification.

Plant species were assigned numerical values that corresponded to ecological indices from the National Wetland Plant List (Reed 1986), based on frequencies of occurrence in wetlands (Table 2). Individuals that could not be identified to species because of advanced phenology were assigned the most conservative ecological index for the genus and were analyzed together. Unidentified species were not used in our analyses.

Weighted averages for individual and combined vegetation strata were calculated for each soil series. The equation used was taken from Wentworth and Johnson (1986):

$$W_j = \left(\sum_{i=1}^n I_{ij} E_i \right) / \left(\sum_{i=1}^n I_{ij} \right)$$

where: W_j = weighted average for stand j ; I_{ij} = importance value for species i in stand j ; E_i = ecological index for species i ; and n = number of species in stand j . Im-

Table 2. Ecological indices used for weighted, presence/absence, and rescaled Michener averages, with definitions of modifiers in the National Wetland Plant Species List (Reed 1986).

| Ecological indices | Index values (E_i) ^a | | | Definition |
|--------------------|-------------------------------------|---|------|---|
| | W | P | M | |
| Obligate | 1 | 1 | 1.00 | Species always occurs in wetlands (frequency >99%) |
| Facultative Wet | 2 | 2 | 1.67 | Species usually occurs in wetlands (67%-99% frequency) |
| Facultative | 3 | 3 | 3.00 | Species sometimes occurs in wetlands (34%-66% frequency) |
| Facultative Upland | 4 | 4 | 4.33 | Species seldom occurs in wetlands (1%-33% frequency) |
| Upland | 5 | 5 | 5.00 | Species occurs in wetlands with less than 1% frequency; also includes species not assigned one of the above modifiers |

^aNumerical values assigned to ecological indices as specified by weighted (W) (Wentworth and Johnson 1986), presence/absence average (P), and Michener (1983) average (M) equations.

portance values correspond to "variables measured" listed in Table 1, and ecological indices assigned to species are listed in Table 2.

Modified Wentworth and Johnson (1986) equations were used to calculate presence/absence averages (P_i), referred to as index averaging by Wentworth and Johnson (1986), and Michener (1983) averages (M_i) for vegetation strata within soil series. Presence/absence averages used the same ecological index values (E_i) as did weighted averages (Table 2); however, the importance value (I_{ij}) was equal to 1 when a species was present in a quadrat or 0 when absent. Michener averages used the same importance values as weights, but they had ecological index values that skewed facultative wetland and upland values toward obligate wetland and upland values, respectively (Table 2).

Frequencies based on density measurements were calculated for taxa by vegetation strata within each soil series. Means, standard errors of means, and ranges also were calculated for weighted, presence/absence, and Michener averages by vegetation strata within each soil series. Averages generated by the three methods were analyzed using Analysis of Variance and Duncan's multiple range

tests. Soil series having weighted, presence/absence averages, and Michener averages less than 3.0 were designated as supporting predominantly hydrophytic vegetation, an indicator of wetland conditions.

RESULTS

Of the 151 taxa identified in our study (Appendix B), 144 occurred in the ground cover stratum, 16 in the shrub stratum, and 11 in the tree stratum (Appendix C). Frequencies of occurrence of taxa encountered in soil series within each vegetation strata are given in Appendix C.

Means, standard errors of means, and ranges were calculated for weighted averages, presence/absence averages, and Michener averages for soil series and sampling sites within vegetation strata (Tables 3, 4, and 5). Mean values for soil series within vegetation strata also were analyzed using Duncan's multiple range tests (Tables 6, 7, and 8); values assigned the same letters were not statistically different. Soil series that are designated as supporting predominantly hydrophytic vegetation are those with calculated mean values less than 3.0; soils considered hydric by the Soil Conservation Service (1985) are indicated with asterisks (*).

Correlations between hydric soils and a prevalence of hydrophytic vegetation were not consistent. Mean values of hydric soils within each vegetation strata were less than 3.0 with one exception; mean values for the Plummer series in the tree stratum were greater than 3.0 (using all averaging methods), even though the series is included in the Hydric Soils List. No significant differences existed between the nonhydric Harleston soil and those series designated as hydric by the Soil Conservation Service (Atmore, Croatan, Hyde, and Plummer). No separation of hydric and nonhydric soils occurred in the tree and shrub strata, and although the Harleston series was statistically different from the hydric series in the ground cover stratum, the mean value for the series was less than 3.0, which indicated a prevalence of hydrophytic vegetation.

DISCUSSION

Good correlations were observed between the hydric soils identified in the Hydric Soils List (Soil Conservation Service 1985) and a predominance of hydrophytic vegetation identified in the National Wetland Plant List (Reed 1986). In general, weighted, presence/absence, and Michener averages indicated that the hydric soils (Atmore, Croatan, Hyde, and Plummer) supported primarily hydrophytic vegetation. However, none of the three methods clearly distinguished the hydric soils from nonhydric Harleston soil based on vegetation composition.

Several hypotheses can be offered as to why hydric and nonhydric soil series were not statistically separable using our vegetation data. First, the Wentworth and Johnson (1986) methodologies may not be adequate for discriminating between all hydric and nonhydric soils; however, these methods originally were tested with a broad data base from North Carolina, Nebraska, Montana, Washington, and Texas wetland systems. Recent investigations in California (Baad 1988; Eicher 1988), Nebraska (Erickson and Leslie 1987), Nevada (Nachlinger 1988), New Mexico (Dick-Peddie et al. 1987), North Carolina (Christensen et al. 1988), and South

Table 3. Means, standard errors of means, and ranges for weighted averages for soil series and sampling sites within vegetation strata.

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| GROUND COVER STRATUM | | | | |
| *Atmore | 40 | 1.641 | 0.022 | 0.596 |
| 1 | 10 | 1.553 | 0.058 | 0.596 |
| 2 | 10 | 1.691 | 0.048 | 0.450 |
| 3 | 10 | 1.648 | 0.029 | 0.311 |
| 4 | 10 | 1.670 | 0.024 | 0.233 |
| *Croatan | 40 | 1.460 | 0.065 | 1.429 |
| 1 | 10 | 1.986 | 0.120 | 1.254 |
| 2 | 10 | 1.208 | 0.060 | 0.435 |
| 3 | 10 | 1.359 | 0.071 | 0.668 |
| 4 | 10 | 1.285 | 0.091 | 0.929 |
| *Hyde | 40 | 1.972 | 0.046 | 1.127 |
| 1 | 10 | 1.956 | 0.072 | 0.640 |
| 2 | 10 | 2.304 | 0.088 | 0.820 |
| 3 | 10 | 1.785 | 0.046 | 0.467 |
| 4 | 10 | 1.841 | 0.057 | 0.608 |
| *Plummer | 40 | 1.820 | 0.041 | 1.139 |
| 1 | 10 | 1.550 | 0.032 | 0.307 |
| 2 | 10 | 1.866 | 0.069 | 0.648 |
| 3 | 10 | 1.860 | 0.057 | 0.580 |
| 4 | 10 | 2.002 | 0.092 | 0.862 |
| Harleston | 40 | 2.396 | 0.102 | 2.725 |
| 1 | 10 | 3.125 | 0.196 | 1.811 |
| 2 | 10 | 2.650 | 0.088 | 0.939 |
| 3 | 10 | 1.841 | 0.076 | 0.780 |
| 4 | 10 | 1.970 | 0.078 | 0.886 |

(Continued)

Table 3. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| SMALL SHRUB STRATUM | | | | |
| *Atmore | 03 | 2.000 | 0.000 | 0.000 |
| 2 | 01 | 2.000 | -- ^c | 0.000 |
| 3 | 01 | 2.000 | -- | 0.000 |
| 4 | 01 | 2.000 | -- | 0.000 |
| *Croatan | 08 | 2.150 | 0.080 | 0.500 |
| 1 | 04 | 2.300 | 0.122 | 0.500 |
| 2 | 01 | 2.000 | -- | 0.000 |
| 4 | 03 | 2.000 | 0.000 | 0.000 |
| *Hyde | 15 | 2.041 | 0.029 | 0.375 |
| 1 | 05 | 2.000 | 0.000 | 0.000 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.123 | 0.078 | 0.375 |
| *Plummer | 15 | 2.067 | 0.067 | 1.000 |
| 1 | 01 | 3.000 | -- | 0.000 |
| 2 | 04 | 2.000 | 0.000 | 0.000 |
| 3 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.000 | 0.000 | 0.000 |
| Harleston | 15 | 2.002 | 0.002 | 0.032 |
| 1 | 01 | 2.000 | -- | 0.000 |
| 2 | 04 | 2.000 | 0.000 | 0.000 |
| 3 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.006 | 0.006 | 0.032 |
| LARGE SHRUB STRATUM | | | | |
| *Croatan | 01 | 2.000 | -- | 0.000 |
| 1 | 01 | 2.000 | -- | 0.000 |

(Continued)

Table 3. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| *Plummer | 01 | 2.000 | -- | 0.000 |
| 4 | 01 | 2.000 | -- | 0.000 |
| Harleston | 02 | 2.000 | 0.000 | 0.000 |
| 2 | 02 | 2.000 | 0.000 | 0.000 |
| TREE STRATUM | | | | |
| *Croatan | 20 | 1.757 | 0.108 | 1.449 |
| 1 | 05 | 2.225 | 0.110 | 0.519 |
| 2 | 05 | 1.672 | 0.181 | 0.955 |
| 3 | 05 | 1.212 | 0.076 | 0.390 |
| 4 | 05 | 1.917 | 0.187 | 1.070 |
| *Hyde | 05 | 2.200 | 0.200 | 1.000 |
| 1 | 02 | 2.500 | 0.500 | 1.000 |
| 2 | 03 | 2.000 | 0.000 | 0.000 |
| *Plummer | 11 | 3.091 | 0.315 | 2.000 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 3 | 04 | 4.000 | 0.000 | 0.000 |
| 4 | 02 | 4.000 | 0.000 | 0.000 |
| Harleston | 11 | 2.036 | 0.030 | 0.327 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 3 | 01 | 2.000 | -- | 0.000 |
| 4 | 05 | 2.079 | 0.063 | 0.327 |
| COMBINED STRATA | | | | |
| *Atmore | 20 | 1.671 | 0.032 | 0.609 |
| 1 | 05 | 1.570 | 0.060 | 0.332 |
| 2 | 05 | 1.711 | 0.090 | 0.510 |

(Continued)

Table 3. (Concluded)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| 3 | 05 | 1.693 | 0.053 | 0.307 |
| 4 | 05 | 1.711 | 0.038 | 0.210 |
| *Croatan | 20 | 1.638 | 0.082 | 1.138 |
| 1 | 05 | 2.119 | 0.033 | 0.161 |
| 2 | 05 | 1.502 | 0.100 | 0.576 |
| 3 | 05 | 1.289 | 0.087 | 0.511 |
| 4 | 05 | 1.643 | 0.121 | 0.736 |
| *Hyde | 20 | 1.972 | 0.037 | 0.649 |
| 1 | 05 | 2.040 | 0.057 | 0.312 |
| 2 | 05 | 2.103 | 0.036 | 0.222 |
| 3 | 05 | 1.751 | 0.056 | 0.282 |
| 4 | 05 | 1.994 | 0.034 | 0.172 |
| *Plummer | 20 | 2.097 | 0.092 | 1.243 |
| 1 | 05 | 1.723 | 0.156 | 0.829 |
| 2 | 05 | 1.924 | 0.038 | 0.202 |
| 3 | 05 | 2.487 | 0.119 | 0.618 |
| 4 | 05 | 2.254 | 0.186 | 0.897 |
| Harleston | 20 | 2.282 | 0.118 | 1.924 |
| 1 | 05 | 2.995 | 0.290 | 1.425 |
| 2 | 05 | 2.189 | 0.027 | 1.161 |
| 3 | 05 | 1.918 | 0.050 | 0.260 |
| 4 | 05 | 2.027 | 0.016 | 0.095 |

^aAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).

^bDifference between maximum and minimum observations.

^cIndicates that the standard error of means was not calculated due to inadequate sample size.

Table 4. Means, standard errors of means, and ranges for presence/absence averages by soil series and sampling sites within vegetation strata.

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| GROUND COVER STRATUM | | | | |
| *Atmore | 40 | 1.701 | 0.022 | 0.545 |
| 1 | 10 | 1.585 | 0.037 | 0.422 |
| 2 | 10 | 1.653 | 0.042 | 0.440 |
| 3 | 10 | 1.828 | 0.035 | 0.303 |
| 4 | 10 | 1.736 | 0.023 | 0.186 |
| *Croatan | 40 | 1.586 | 0.064 | 1.667 |
| 1 | 10 | 1.988 | 0.121 | 1.333 |
| 2 | 10 | 1.487 | 0.134 | 1.000 |
| 3 | 10 | 1.507 | 0.065 | 0.583 |
| 4 | 10 | 1.362 | 0.092 | 1.000 |
| *Hyde | 40 | 1.975 | 0.027 | 0.697 |
| 1 | 10 | 2.007 | 0.062 | 0.697 |
| 2 | 10 | 2.162 | 0.039 | 0.366 |
| 3 | 10 | 1.886 | 0.022 | 0.208 |
| 4 | 10 | 1.845 | 0.023 | 0.280 |
| *Plummer | 40 | 1.812 | 0.022 | 0.669 |
| 1 | 10 | 1.774 | 0.028 | 0.296 |
| 2 | 10 | 1.815 | 0.063 | 0.545 |
| 3 | 10 | 1.830 | 0.025 | 0.255 |
| 4 | 10 | 1.829 | 0.057 | 0.583 |
| Harleston | 40 | 2.151 | 0.053 | 1.429 |
| 1 | 10 | 2.517 | 0.109 | 0.882 |
| 2 | 10 | 2.042 | 0.056 | 0.500 |
| 3 | 10 | 1.946 | 0.077 | 0.867 |
| 4 | 10 | 2.099 | 0.080 | 0.829 |

(Continued)

Table 4. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| SMALL SHRUB STRATUM | | | | |
| *Atmore | 03 | 2.000 | 0.000 | 0.000 |
| 2 | 01 | 2.000 | -- ^c | 0.000 |
| 3 | 01 | 2.000 | -- | 0.000 |
| 4 | 01 | 2.000 | -- | 0.000 |
| *Croatan | 08 | 2.167 | 0.083 | 0.500 |
| 1 | 04 | 2.333 | 0.118 | 0.500 |
| 2 | 01 | 2.000 | -- | 0.000 |
| 4 | 03 | 2.000 | 0.000 | 0.000 |
| *Hyde | 15 | 2.050 | 0.036 | 0.500 |
| 1 | 05 | 2.000 | 0.000 | 0.000 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.150 | 0.100 | 0.500 |
| *Plummer | 15 | 2.067 | 0.067 | 1.000 |
| 1 | 01 | 3.000 | -- | 0.000 |
| 2 | 04 | 2.000 | 0.000 | 0.000 |
| 3 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.000 | 0.000 | 0.000 |
| Harleston | 15 | 2.011 | 0.011 | 0.167 |
| 1 | 01 | 2.000 | -- | 0.000 |
| 2 | 04 | 2.000 | 0.000 | 0.000 |
| 3 | 05 | 2.000 | 0.000 | 0.000 |
| 4 | 05 | 2.033 | 0.033 | 0.167 |
| LARGE SHRUB STRATUM | | | | |
| *Croatan | 01 | 2.000 | -- | 0.000 |
| 1 | 01 | 2.000 | -- | 0.000 |

(Continued)

Table 4. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| *Plummer | 01 | 2.000 | -- | 0.000 |
| 4 | 01 | 2.000 | -- | 0.000 |
| Harleston | 02 | 2.000 | 0.000 | 0.000 |
| 2 | 02 | 2.000 | 0.000 | 0.000 |
| TREE STRATUM | | | | |
| *Croatan | 20 | 2.199 | 0.070 | 1.167 |
| 1 | 05 | 2.330 | 0.088 | 0.467 |
| 2 | 05 | 2.433 | 0.125 | 0.667 |
| 3 | 05 | 2.033 | 0.186 | 1.167 |
| 4 | 05 | 2.000 | 0.000 | 0.000 |
| *Hyde | 05 | 2.200 | 0.200 | 1.000 |
| 1 | 02 | 2.500 | 0.500 | 1.000 |
| 2 | 03 | 2.000 | 0.000 | 0.000 |
| *Plummer | 11 | 3.091 | 0.315 | 2.000 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 3 | 04 | 4.000 | 0.000 | 0.000 |
| 4 | 02 | 4.000 | 0.000 | 0.000 |
| Harleston | 11 | 2.091 | 0.061 | 0.500 |
| 2 | 05 | 2.000 | 0.000 | 0.000 |
| 3 | 01 | 2.000 | -- | 0.000 |
| 4 | 05 | 2.200 | 0.122 | 0.500 |
| COMBINED STRATA | | | | |
| *Atmore | 20 | 1.725 | 0.029 | 0.407 |
| 1 | 05 | 1.609 | 0.051 | 0.284 |
| 2 | 05 | 1.687 | 0.074 | 0.396 |

(Continued)

Table 4. (Concluded)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| 3 | 05 | 1.834 | 0.020 | 0.101 |
| 4 | 05 | 1.773 | 0.025 | 0.144 |
| *Croatan | 20 | 1.913 | 0.060 | 0.861 |
| 1 | 05 | 2.196 | 0.041 | 0.237 |
| 2 | 05 | 1.955 | 0.144 | 0.708 |
| 3 | 05 | 1.752 | 0.106 | 0.583 |
| 4 | 05 | 1.749 | 0.041 | 0.190 |
| *Hyde | 20 | 1.993 | 0.026 | 0.498 |
| 1 | 05 | 2.060 | 0.060 | 0.328 |
| 2 | 05 | 2.044 | 0.025 | 0.150 |
| 3 | 05 | 1.861 | 0.025 | 0.160 |
| 4 | 05 | 2.005 | 0.042 | 0.220 |
| *Plummer | 20 | 2.121 | 0.080 | 0.990 |
| 1 | 05 | 1.926 | 0.128 | 0.740 |
| 2 | 05 | 1.913 | 0.039 | 0.213 |
| 3 | 05 | 2.460 | 0.135 | 0.696 |
| 4 | 05 | 2.187 | 0.189 | 0.821 |
| Harleston | 20 | 2.140 | 0.056 | 0.931 |
| 1 | 05 | 2.452 | 0.126 | 0.685 |
| 2 | 05 | 2.012 | 0.015 | 0.091 |
| 3 | 05 | 1.963 | 0.052 | 0.274 |
| 4 | 05 | 2.131 | 0.063 | 0.367 |

^aAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).

^bDifference between maximum and minimum observations.

^cIndicates that the standard error of means was not calculated due to inadequate sample size.

Table 5. Means, standard errors of means, and ranges for rescaled Michener averages by soil series and sampling sites within vegetation strata.

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| GROUND COVER STRATUM | | | | |
| *Atmore | 40 | 1.561 | 0.022 | 0.604 |
| 1 | 10 | 1.498 | 0.062 | 0.604 |
| 2 | 10 | 1.600 | 0.050 | 0.484 |
| 3 | 10 | 1.579 | 0.034 | 0.398 |
| 4 | 10 | 1.567 | 0.024 | 0.224 |
| *Croatan | 40 | 1.369 | 0.054 | 1.240 |
| 1 | 10 | 1.768 | 0.117 | 1.123 |
| 2 | 10 | 1.184 | 0.057 | 0.420 |
| 3 | 10 | 1.329 | 0.068 | 0.664 |
| 4 | 10 | 1.195 | 0.065 | 0.669 |
| *Hyde | 40 | 1.875 | 0.045 | 1.161 |
| 1 | 10 | 1.806 | 0.065 | 0.611 |
| 2 | 10 | 2.201 | 0.091 | 0.827 |
| 3 | 10 | 1.720 | 0.051 | 0.535 |
| 4 | 10 | 1.772 | 0.061 | 0.643 |
| *Plummer | 40 | 1.715 | 0.044 | 1.225 |
| 1 | 10 | 1.454 | 0.029 | 0.263 |
| 2 | 10 | 1.725 | 0.068 | 0.673 |
| 3 | 10 | 1.757 | 0.060 | 0.583 |
| 4 | 10 | 1.924 | 0.108 | 1.074 |
| Harleston | 40 | 2.271 | 0.114 | 2.698 |
| 1 | 10 | 3.118 | 0.195 | 1.803 |
| 2 | 10 | 2.601 | 0.095 | 1.027 |
| 3 | 10 | 1.641 | 0.074 | 0.826 |
| 4 | 10 | 1.724 | 0.056 | 0.650 |

(Continued)

Table 5. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| SMALL SHRUB STRATUM | | | | |
| *Atmore | 03 | 1.670 | 0.000 | 0.000 |
| 2 | 01 | 1.670 | -- ^c | 0.000 |
| 3 | 01 | 1.670 | -- | 0.000 |
| 4 | 01 | 1.670 | -- | 0.000 |
| *Croatan | 08 | 1.870 | 0.107 | 0.665 |
| 1 | 04 | 2.069 | 0.163 | 0.665 |
| 2 | 01 | 1.670 | -- | 0.000 |
| 4 | 03 | 1.670 | 0.000 | 0.000 |
| *Hyde | 15 | 1.724 | 0.038 | 0.499 |
| 1 | 05 | 1.670 | 0.000 | 0.000 |
| 2 | 05 | 1.670 | 0.000 | 0.000 |
| 4 | 05 | 1.833 | 0.104 | 0.499 |
| *Plummer | 15 | 1.759 | 0.089 | 1.330 |
| 1 | 01 | 3.000 | -- | 0.000 |
| 2 | 04 | 1.670 | 0.000 | 0.000 |
| 3 | 05 | 1.670 | 0.000 | 0.000 |
| 4 | 05 | 1.670 | 0.000 | 0.000 |
| Harleston | 15 | 1.673 | 0.003 | 0.043 |
| 1 | 01 | 1.670 | -- | 0.000 |
| 2 | 04 | 1.670 | 0.000 | 0.000 |
| 3 | 05 | 1.670 | 0.000 | 0.000 |
| 4 | 05 | 1.679 | 0.009 | 0.043 |
| LARGE SHRUB STRATUM | | | | |
| *Croatan | 01 | 1.670 | -- | 0.000 |
| 1 | 01 | 1.670 | -- | 0.000 |

(Continued)

Table 5. (Continued)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| *Plummer | 01 | 1.670 | -- | 0.000 |
| 4 | 01 | 1.670 | -- | 0.000 |
| Harleston | 02 | 1.670 | 0.000 | 0.000 |
| 2 | 02 | 1.670 | 0.000 | 0.000 |
| TREE STRATUM | | | | |
| *Croatan | 20 | 1.701 | 0.101 | 1.436 |
| 1 | 05 | 2.027 | 0.159 | 0.780 |
| 2 | 05 | 1.680 | 0.185 | 0.977 |
| 3 | 05 | 1.210 | 0.078 | 0.400 |
| 4 | 05 | 1.887 | 0.181 | 1.066 |
| *Hyde | 05 | 1.936 | 0.266 | 1.330 |
| 1 | 02 | 2.335 | 0.665 | 1.330 |
| 2 | 03 | 1.670 | 0.000 | 0.000 |
| *Plummer | 11 | 3.121 | 0.419 | 2.660 |
| 2 | 05 | 1.670 | 0.000 | 0.000 |
| 3 | 04 | 4.330 | 0.000 | 0.000 |
| 4 | 02 | 4.330 | 0.000 | 0.000 |
| Harleston | 11 | 1.718 | 0.040 | 0.435 |
| 2 | 05 | 1.670 | 0.000 | 0.000 |
| 3 | 01 | 1.670 | -- | 0.000 |
| 4 | 05 | 1.775 | 0.084 | 0.435 |
| COMBINED STRATA | | | | |
| *Atmore | 20 | 1.571 | 0.029 | 0.593 |
| 1 | 05 | 1.513 | 0.071 | 0.360 |
| 2 | 05 | 1.599 | 0.091 | 0.533 |

(Continued)

Table 5. (Concluded)

| Soil series ^a / sampling site | N | Mean | Standard error of means | Range ^b |
|---|----|-------|-------------------------------|--------------------|
| 3 | 05 | 1.592 | 0.038 | 0.217 |
| 4 | 05 | 1.580 | 0.015 | 0.085 |
| *Croatan | 20 | 1.548 | 0.066 | 0.977 |
| 1 | 05 | 1.912 | 0.050 | 0.288 |
| 2 | 05 | 1.474 | 0.101 | 0.589 |
| 3 | 05 | 1.272 | 0.087 | 0.509 |
| 4 | 05 | 1.535 | 0.097 | 0.592 |
| *Hyde | 20 | 1.791 | 0.031 | 0.595 |
| 1 | 05 | 1.818 | 0.076 | 0.403 |
| 2 | 05 | 1.860 | 0.033 | 0.191 |
| 3 | 05 | 1.678 | 0.063 | 0.340 |
| 4 | 05 | 1.808 | 0.049 | 0.254 |
| *Plummer | 20 | 1.957 | 0.106 | 1.307 |
| 1 | 05 | 1.634 | 0.163 | 0.866 |
| 2 | 05 | 1.666 | 0.031 | 0.166 |
| 3 | 05 | 2.417 | 0.154 | 0.799 |
| 4 | 05 | 2.109 | 0.237 | 1.116 |
| Harleston | 20 | 2.069 | 0.140 | 2.135 |
| 1 | 05 | 2.947 | 0.318 | 1.581 |
| 2 | 05 | 1.946 | 0.032 | 0.193 |
| 3 | 05 | 1.654 | 0.047 | 0.266 |
| 4 | 05 | 1.730 | 0.035 | 0.188 |

^aAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conservation Service 1985).

^bDifference between maximum and minimum observations.

^cIndicates that the standard error of means was not calculated due to inadequate sample size.

Table 6. Duncan multiple range tests for weighted averages calculated for soil series within vegetation strata.

| Duncan grouping ^a | Soil series ^b | Mean | N |
|------------------------------|--------------------------|-------|----|
| GROUND COVER STRATUM | | | |
| A | Harleston | 2.396 | 40 |
| B | *Hyde | 1.972 | 40 |
| B | *Plummer | 1.820 | 40 |
| C | *Atmore | 1.641 | 40 |
| D | *Croatan | 1.460 | 40 |
| SMALL SHRUB STRATUM | | | |
| A | *Croatan | 2.150 | 08 |
| A | *Plummer | 2.067 | 15 |
| A | *Hyde | 2.041 | 15 |
| A | Harleston | 2.002 | 15 |
| A | *Atmore | 2.000 | 03 |
| LARGE SHRUB STRATUM | | | |
| A | *Croatan | 2.000 | 01 |
| A | *Plummer | 2.000 | 01 |
| A | Harleston | 2.000 | 02 |
| TREE STRATUM | | | |
| A | *Plummer | 3.091 | 11 |
| B | *Hyde | 2.200 | 05 |
| B | Harleston | 2.036 | 11 |
| B | *Croatan | 1.757 | 20 |
| COMBINED STRATA | | | |
| A | Harleston | 2.282 | 20 |
| A | *Plummer | 2.097 | 20 |
| A | *Hyde | 1.972 | 20 |
| B | *Atmore | 1.671 | 20 |
| B | *Croatan | 1.638 | 20 |

^aMean values for soil series within the same letter grouping are not statistically different.

^bAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Table 7. Duncan multiple range tests for presence/absence averages calculated for soil series by vegetation strata.

| Duncan grouping ^a | Soil series ^b | Mean | N |
|------------------------------|--------------------------|-------|----|
| GROUND COVER STRATUM | | | |
| A | Harleston | 2.151 | 40 |
| B | *Hyde | 1.975 | 40 |
| C | *Plummer | 1.812 | 40 |
| C,D | *Atmore | 1.701 | 40 |
| D | *Croatan | 1.586 | 40 |
| SMALL SHRUB STRATUM | | | |
| A | *Croatan | 2.167 | 08 |
| A | *Plummer | 2.067 | 15 |
| A | *Hyde | 2.050 | 15 |
| A | Harleston | 2.011 | 15 |
| A | *Atmore | 2.000 | 03 |
| LARGE SHRUB STRATUM | | | |
| A | *Croatan | 2.000 | 01 |
| A | *Plummer | 2.000 | 01 |
| A | Harleston | 2.000 | 02 |
| TREE STRATUM | | | |
| A | *Plummer | 3.091 | 11 |
| B | *Hyde | 2.200 | 05 |
| B | *Croatan | 2.199 | 20 |
| B | Harleston | 2.091 | 11 |
| COMBINED STRATA | | | |
| A | Harleston | 2.140 | 20 |
| A | *Plummer | 2.121 | 20 |
| A | *Hyde | 1.993 | 20 |
| A | *Croatan | 1.913 | 20 |
| B | *Atmore | 1.725 | 20 |

^aMean values for soil series with the same letter grouping are not statistically different.

^bAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Table 8. Duncan multiple range tests for rescaled Michener averages calculated for soil series by vegetation strata.

| Duncan grouping ^a | Soil series ^b | Mean | N |
|------------------------------|--------------------------|-------|----|
| GROUND COVER STRATUM | | | |
| A | Harleston | 2.271 | 40 |
| B | *Hyde | 1.875 | 40 |
| B,C | *Plummer | 1.715 | 40 |
| C | *Atmore | 1.561 | 40 |
| D | *Croatan | 1.369 | 40 |
| SMALL SHRUB STRATUM | | | |
| A | *Croatan | 1.869 | 08 |
| A | *Plummer | 1.759 | 15 |
| A | *Hyde | 1.724 | 15 |
| A | Harleston | 1.673 | 15 |
| A | *Atmore | 1.670 | 03 |
| LARGE SHRUB STRATUM | | | |
| A | Harleston | 1.670 | 02 |
| A | *Plummer | 1.670 | 01 |
| A | *Croatan | 1.670 | 01 |
| TREE STRATUM | | | |
| A | *Plummer | 3.121 | 11 |
| B | *Hyde | 1.936 | 05 |
| B | Harleston | 1.718 | 11 |
| B | *Croatan | 1.701 | 20 |
| COMBINED STRATA | | | |
| A | Harleston | 2.069 | 20 |
| A | *Plummer | 1.957 | 20 |
| A | *Hyde | 1.791 | 20 |
| B | *Atmore | 1.571 | 20 |
| B | *Croatan | 1.548 | 20 |

^aMean values for soil series with the same letter grouping are not statistically different.

^bAsterisks (*) indicate that the soil series is included in the Hydric Soils List (Soil Conserv. Serv. 1985).

Dakota (Hubbard et al. 1988) generally support the concept that weighted average values can discriminate between hydric and nonhydric soils. Thus, it is unlikely that Wentworth and Johnson (1986) methods would not be appropriate for Mississippi coastal wetlands.

Second, low numbers of species and/or sampling sites in the shrub and tree strata may have been insufficient for statistical analyses and thus were inadequate for separating soil series based on vegetation in some strata. For example, the Plummer series, which is a Soil Conservation Service hydric soil, had mean values for the tree stratum that were greater than 3.0 (indicating that the series did not support predominantly wetland vegetation). However, those calculations were based on data from only two species (*Pinus palustris*, classified as a facultative upland species, and *P. elliotii*, classified as a facultative wetland species). Sufficient numbers of species and samples were obtained in the ground cover vegetation, and subsequent analyses of this stratum separated the nonhydric Harleston soil from the hydric series. Although all three methods (weighted, presence/absence, and Michener averages) indicated that the Harleston series differed from the other soils in its composition of ground cover vegetation, a predominance of upland flora (indicating nonhydric conditions) was not observed.

Third, it is possible that the Harleston soil is misclassified as nonhydric. Minimal elevational changes between the Harleston soil and wetland sites and/or a high water table in these coastal habitats may permit hydrophytic species to grow on soil series that have been considered nonhydric by the Soil Conservation Service. A maritime climate could maintain moist conditions, at least seasonally, in upland areas, allowing hydrophytic plants to colonize such habitats. Further research is necessary to test this hypothesis.

Correspondence among averaging methods indicated that both the nonhydric Harleston series and the hydric soils supported hydrophytic vegetation and are more similar in their hydric affinities than previously believed. The Soil Conservation Service describes the Harleston series as formed in marine or stream deposits, which may indicate hydric influences (see Appendix A). Inclusion of the Harleston series in the Hydric Soils List (Soil Conservation Service 1985) appears to warrant further consideration.

CONCLUSIONS

Weighted, presence/absence, and Michener averages were calculated for soil series within vegetational strata in the Mississippi Sandhill Crane National Wildlife Refuge, and then compared using Duncan's multiple range test. Mean values less than 3.0 indicated that the soil series supported primarily hydrophytic vegetation.

Good correlations were seen between Soil Conservation Service (1985) hydric soils and hydrophytic vegetation identified in the National Wetland Plant List (Reed 1986). Most values generated for hydric soils series (Atmore, Croatan, Hyde, and Plummer) were less than 3.0; one exception was the Plummer soil series in the tree stratum.

The nonhydric Harleston series was not statistically separable from the hydric soils in tree, shrub, and combined strata; only ground cover vegetation data provided

some means for differentiating hydric and nonhydric soils, although averages were below 3.0. Possible explanations why our data did not adequately separate hydric from nonhydric soils include: (1) the vegetation on the nonhydric Harleston series was influenced by a high water table, resulting in a preponderance of hydrophytic vegetation; and (2) the Harleston series should be included on the Hydric Soils List (Soil Conservation Service 1985). Further research will be required to determine the status of the Harleston series.

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APPENDIX A

DESCRIPTIONS OF SOIL SERIES

ATMORE: formerly Rains series; consists of deep, poorly drained, moderately slowly permeable soils formed in loamy marine sediments; located at depressions and interstream divides; with 0-5% slope; typical pedon: Ap--0-18 cm, dark gray silt loam with few fine gray mottles, friable, strongly acid; Eg--18-33 cm, gray silt loam, few distinct strong brown mottles, friable, strongly acid; Bg/Eg--33-76 cm, light gray silt loam, many coarse distinct yellow and common medium distinct yellowish brown mottles, slightly sticky, strongly acid; Btvg1--76-122 cm, light gray silt loam, common coarse distinct yellow, yellowish red, and yellowish brown mottles, slightly sticky in the saturated gray areas, strongly acid; Btvg2--122-178 cm, mottled light gray, dark red, and yellow silty clay loam, sticky in saturated gray areas, firm, brittle, and compact in dark red area and in some of the yellow areas, strongly acid; most of the soil is used for woodland or pasture; forested areas are of slash, loblolly, and longleaf pine with an understory of gallberry, saw palmetto, wiregrass, and pitcher plant; distribution of Coastal Plain throughout Alabama, Florida, Mississippi, and possibly Louisiana and Texas.

CROATAN: formerly Swamp series; consists of very poorly drained, organic soils that formed in highly decomposed organic material underlain by loamy textured marine and fluvial sediment; with 0-2% slope; typical pedon: Oa1--0-23 cm, black broken face and rubbed sapric material, very friable, about 95% organic content, extremely acid; Oa2--23-38 cm, black broken face and rubbed sapric material, very friable, about 90% organic content, extremely acid; Oa3--38-71 cm, black broken face rubbed sapric material, very friable, about 75% organic content, extremely acid; 2Ag--71-84 cm, black mucky sandy loam, very friable, about 80% mineral content, extremely acid; 2Cg1--84-97 cm, dark brown sandy loam, very friable, extremely acid; 2Cg2--97-152 cm, grayish brown sandy clay loam, slightly sticky, slightly plastic, extremely acid; 2Cg3--152-203 cm, mottled grayish brown and dark gray loamy sand, very friable, extremely acid; most of the soil is wooded, with native vegetation consisting of titi, gallberry, greenbriar, sphagnum moss, redbay, sweetbay, swamp tupelo, and bald cypress; distribution from Middle and Lower Coastal Plain of Alabama, North Carolina, South Carolina, Virginia, and possibly Florida and Mississippi.

HARLESTON: formerly Goldsboro and Lynchburg series; consists of deep, moderately well drained, moderately permeable soils that formed in marine or stream deposits consisting of thick beds of sandy loam; with 0-12% slope; typical pedon: Ap--0-13 cm, very dark gray loam, very friable, very strongly acid; E--13-23 cm, light olive brown loam, very friable, very strongly acid; Bt1--23-51 cm, yellowish brown loam, friable, patchy clay films, very strongly acid; Bt2--51-66 cm, yellowish brown loam, many medium and coarse distinct yellowish red and common medium distinct light brownish gray mottles, patchy clay film, very strongly acid; Bt3--66-84 cm, brownish yellow loam, common medium distinct light brownish gray, pale brown, and strong brown mottles, friable, few pockets of sandy loam, very strongly acid; Bt4--84-152 cm, yellowish brown loam, many medium and coarse distinct brown and light brownish gray mottles, friable, slightly brittle, patchy clay films, very strongly acid; Bt5--152-183 cm, coarsely mottled red, gray, yellowish brown, and strong brown sandy clay loam, friable, slightly brittle, patchy clay films, very strongly acid; most soil is in pine forest, with understory of gallberry, wax myrtle, and native grasses; distribution of the Southern Coastal Plain in Mississippi, Alabama, and Arkansas.

HYDE: formerly Bayboro series; very poorly drained soil, with moderately slow permeability, that formed in marine and fluvial deposits of silts, sands, and clays; located in nearly level areas and slight depressions; with 0-2% slope; typical pedon: Ap--0-25 cm, black loam, very friable, high organic content, very strongly acid; A12--25-38 cm, very dark gray loam, friable, medium organic content, very strongly acid; B2tg--38-89 cm, dark gray clay loam, few medium distinct strong brown mottles, friable, slightly sticky and plastic, very strongly acid; B3g--89-114 cm, dark gray clay loam, few medium distinct strong brown mottles, firm, slightly sticky and plastic,

very strongly acid; C1g--114-140 cm, gray clay loam, few distinct yellowish brown mottles, firm, very strongly acid; C2g--140-165 cm, gray clay loam, common medium yellowish brown mottles, firm, some pockets of fine sandy loam and clay, strongly acid; largely in forested areas of water-tolerant oaks, sweetgum, blackgum, bald cypress, pines, wax myrtle, and maples; distribution of Coastal Plains of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Virginia, and possibly Maryland.

PLUMMER: consists of deep, poorly drained, moderately permeable soils that formed in sandy and loamy sediments of marine terraces; located at level or depressional landscapes and along poorly defined drains; with 0-1% slope; typical pedon: A1--0-23 cm, dark gray sand, very friable, very strongly acid; A21g--23-71 cm, light gray sand, loose, very strongly acid; A22g--71-127 cm, light gray sand, loose, very strongly acid; B2tg--127-183 cm, light gray sandy loam with bodies of sandy clay loam, common medium and fine distinct yellowish brown mottles, friable, very strongly acid; mostly mixed forests of pines, swamp tupelo, and bald cypress, with understory of gallberry, wax myrtle, pitcher plants, wiregrass, and brackenferns; distribution of Atlantic and Gulf Coast Flatwoods, and to a limited extent Southern Coastal Plain, in Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Virginia.

APPENDIX B

**ALPHABETICAL LISTING OF SCIENTIFIC NAMES, CODES, AND
NATIONAL WETLAND INVENTORY ECOLOGICAL INDICES OF PLANT SPECIES
IDENTIFIED AT THE MISSISSIPPI SANDHILL CRANE NATIONAL WILDLIFE REFUGE**

| SCIENTIFIC NAME ^a | CODE ^b | INDEX ^c |
|-------------------------------------|-------------------|--------------------|
| <i>Acer rubrum</i> | ACRU | FAC |
| <i>Agalinis aphylla</i> | AGAP3 | FACW |
| <i>Agalinis obtusifolia</i> | AGOB | FAC* ^d |
| <i>Aletris lutea</i> | ALLU | FACW |
| <i>Andropogon mohrii</i> | ANMO3 | OBL |
| <i>Antennaria</i> sp. | ANTEN | FACU |
| <i>Anthraenantia rufa</i> | ANRU | FACU |
| <i>Aristida affinis</i> | ARAF | OBL |
| <i>Aristida stricta</i> | ARST5 | FAC |
| <i>Arundinaria gigantea</i> | ARGI | FACW |
| <i>Asclepias</i> sp. | ASCLE | FACW |
| <i>Asclepias longifolia</i> | ASLO | FACW |
| <i>Ascyrum stans</i> | ASST2 | FACW |
| <i>Aster dumosus</i> | ASDU | FAC |
| <i>Axonopus affinis</i> | AXAF | FACW |
| <i>Balduina uniflora</i> | BAUN | FACW |
| <i>Bartonia virginica</i> | BAVI3 | FACW |
| <i>Bigelovia nudata</i> | BINU | FACW |
| <i>Bignonia capreolata</i> | BICA | FAC* |
| <i>Burmannia capitata</i> | BUCA3 | OBL* |
| <i>Carex glaucescens</i> | CAGL5 | OBL |
| <i>Carphephorus pseudo-liatris</i> | CAPS5 | OBL* |
| <i>Cassia nictitans</i> | CANI4 | FACU |
| <i>Centella asiatica</i> | CEAS | FACW |
| <i>Chaptalia tomentosa</i> | CHTO | FACW |
| <i>Clethra alnifolia</i> | CLAL3 | FACW |
| <i>Conyza canadensis</i> | COCA5 | FACU |
| <i>Coreopsis linifolia</i> | COLI5 | FACW |
| <i>Coreopsis tripteris</i> | COTR4 | FAC |
| <i>Crotalaria purshii</i> | CRPU5 | UPL* |
| <i>Ctenium aromaticum</i> | CTAR | FACW |
| <i>Cynoctonum sessifolium</i> | CYSE | FACW |
| <i>Cyperus retrorsus</i> | CYRE5 | FACU |
| <i>Cyrilla racemiflora</i> | CYRA | FACW |
| <i>Dichanthelium aciculare</i> | DIAC | FACU |
| <i>Dichanthelium acuminatum</i> | DIAC2 | FAC |
| <i>Dichanthelium dichotomum</i> | DIDI6 | FAC |
| <i>Dichanthelium leucoblepharis</i> | DILE3 | FAC |
| <i>Dichanthelium scabriusculum</i> | DISC2 | OBL |
| <i>Dichromena latifolia</i> | DILA2 | FACW |
| <i>Dicranium acuminatum</i> | DICRA | OBL* ^e |
| <i>Digitaria ciliaris</i> | DICI | UPL* |
| <i>Digitaria ischaemum</i> | DIIS | UPL* |
| <i>Diodia teres</i> | DITE2 | FACU |
| <i>Diodia virginiana</i> | DIVI3 | FACW |
| <i>Drosera capillaris</i> | DRCA2 | OBL |
| <i>Drosera filiformis</i> | DRFI | OBL |
| <i>Eragrostis refracta</i> | ERRE | FACW |

| SCIENTIFIC NAME ^a | CODE ^b | INDEX ^c |
|-----------------------------------|-------------------|--------------------|
| <i>Eriocaulon compressum</i> | ERCO7 | OBL |
| <i>Eriocaulon decangulare</i> | ERDE5 | OBL |
| <i>Erigeron vernus</i> | ERVE | OBL |
| <i>Eryngium integrifolium</i> | ERIN6 | FACW |
| <i>Eryngium yuccifolium</i> | ERYU | FAC |
| <i>Eupatorium</i> sp. | EUPAT | FAC |
| <i>Eupatorium anomalum</i> | EUAN4 | FAC* |
| <i>Eupatorium capillifolium</i> | EUCA5 | FACU |
| <i>Eupatorium compositifolium</i> | EUCO7 | FAC* |
| <i>Eupatorium leucolepsis</i> | EULE | FACW |
| <i>Eupatorium rotundifolium</i> | EURO4 | FAC |
| <i>Eupatorium semiserratum</i> | EUSE | FACW |
| <i>Euphorbia corollata</i> | EUCO10 | UPL* |
| <i>Euthamia minor</i> | EUMI6 | FAC |
| <i>Fimbristylis tomentosa</i> | FITO | FACW |
| <i>Fuirena breviseta</i> | FUBR | OBL |
| <i>Gamochaeta purpurea</i> | GAPU3 | UPL* |
| <i>Gaylussacia mosieri</i> | GAMO3 | FACW* |
| <i>Helianthus heterophyllus</i> | HEHE4 | OBL |
| <i>Heterotheca graminifolia</i> | HEGR10 | UPL |
| <i>Hypericum brachyphyllum</i> | HYBR3 | FACW |
| <i>Hypericum cistifolium</i> | HYCI | FACW |
| <i>Hypericum gentianoides</i> | HYGE | FACU |
| <i>Hypoxis rigida</i> | HYRI2 | FACW |
| <i>Ilex coriacea</i> | ILCO | FACW |
| <i>Ilex glabra</i> | ILGL | FACW |
| <i>Ilex myrtifolia</i> | ILMY | FACW* |
| <i>Juncus</i> sp. | JUNCU | FACW |
| <i>Juncus dichotomus</i> | JUDI | FACW |
| <i>Juncus marginatus</i> | JUMA4 | FACW |
| <i>Lachnanthes caroliniana</i> | LACA5 | OBL |
| <i>Lachnocaulon anceps</i> | LAAN | OBL |
| <i>Liatris spicata</i> | LISP | FACU |
| <i>Linum</i> sp. | LINUM | FAC |
| <i>Linum medium</i> | LIME2 | FAC* |
| <i>Lobelia brevifolia</i> | LOBR3 | FAC |
| <i>Lobelia floridana</i> | LOFL3 | OBL |
| <i>Lophiola americana</i> | LOAM3 | OBL |
| <i>Ludwigia linifolia</i> | LULI | OBL |
| <i>Ludwigia virgata</i> | LUVI2 | OBL |
| <i>Lycopodium alopecuroides</i> | LYAL2 | OBL |
| <i>Lycopodium carolinianum</i> | LYCA3 | OBL |
| <i>Lycopus virginicus</i> | LYVI | OBL |
| <i>Lyonia lucida</i> | LYLU3 | FACW |
| <i>Magnolia grandiflora</i> | MAGR4 | FAC |
| <i>Magnolia virginiana</i> | MAVI2 | FACW |
| <i>Muhlenbergia expansa</i> | MUEX | FACW |
| <i>Myrica</i> sp. | MYRIC | FAC |
| <i>Myrica cerifera</i> | MYCE | FAC |

| SCIENTIFIC NAME ^a | CODE ^b | INDEX ^c |
|--|-------------------|--------------------|
| <i>Myrica heterophyllum</i> | MYHE | FACW |
| <i>Nyssa sylvatica</i> var. <i>biflora</i> | NYSY | FAC |
| <i>Oldenlandia uniflora</i> | OLUN | FACW |
| <i>Oxypolis filiformis</i> | OXFI | FACW |
| <i>Pallavicinia lyellii</i> | PALLA | OBL# |
| <i>Panicum longifolium</i> | PALO | OBL |
| <i>Panicum verrucosum</i> | PAVE2 | FACW |
| <i>Panicum virgatum</i> | PAVI2 | FACW |
| <i>Pinus elliottii</i> | PIEL | FACW |
| <i>Pinus palustris</i> | PIPA2 | FACU |
| <i>Platanthera integra</i> | PLIN5 | OBL |
| <i>Pluchea foetida</i> | PLFO | OBL |
| <i>Polygala cruciata</i> | POCR | OBL |
| <i>Polygala cymosa</i> | POCY | OBL |
| <i>Polygala lutea</i> | POLU | FACW |
| <i>Polypremum procumbens</i> | POPR4 | FACU* |
| <i>Quercus nigra</i> | QUNI | FAC |
| <i>Rhexia alifanus</i> | RHAL4 | FACW |
| <i>Rhexia lutea</i> | RHLU | FACW |
| <i>Rhexia petiolata</i> | RHPE | FACW |
| <i>Rhynchospora</i> sp. | RHYNC | FACW |
| <i>Rhynchospora baldwinii</i> | RHBA | OBL |
| <i>Rhynchospora cephalantha</i> | RHCE | OBL |
| <i>Rhynchospora chapmanii</i> | RHCH3 | OBL |
| <i>Rhynchospora corniculata</i> | RHCO2 | OBL |
| <i>Rhynchospora fascicularis</i> | RHFA | FACW |
| <i>Rhynchospora filifolia</i> | RHFI | FACW |
| <i>Rhynchospora gracilentia</i> | RHGR | OBL |
| <i>Rhynchospora oligantha</i> | RHOL | OBL |
| <i>Rhynchospora pallida</i> | RHPA | OBL |
| <i>Rhynchospora plumosa</i> | RHPL3 | FACW |
| <i>Rhynchospora pusilla</i> | RHPU3 | FACW |
| <i>Rhynchospora rariflora</i> | RHRA2 | OBL |
| <i>Rubus flagellaris</i> | RUFL | UPL* |
| <i>Rubus hispidus</i> | RUHI | FACW* |
| <i>Sabatia campanulata</i> | SACA26 | FACW |
| <i>Sarracenia alata</i> | SAAL4 | OBL |
| <i>Sarracenia psittacina</i> | SAPS2 | OBL |
| <i>Schizachyrium scoparium</i> | SCSC | FACU |
| <i>Scleria</i> sp. | SCLER | FACW |
| <i>Scleria baldwinii</i> | SCBA2 | FACW |
| <i>Scleria reticularis</i> | SCRE | OBL |
| <i>Smilax bona-nox</i> | SMBO2 | FAC |
| <i>Smilax laurifolia</i> | SMLA | FACW |
| <i>Sphagnum</i> sp. | SPHAG | OBL# |
| <i>Taxodium distichum</i> | TADI2 | OBL |
| <i>Tofieldia racemosa</i> | TORA | OBL |
| <i>Tragia smallii</i> | TRSM | UPL* |
| <i>Utricularia juncea</i> | UTJU | OBL |

| SCIENTIFIC NAME ^a | CODE ^b | INDEX ^c |
|------------------------------|-------------------|--------------------|
| <i>Viola lanceolata</i> | VILA4 | OBL |
| <i>Woodwardia areolata</i> | WOAR | OBL |
| <i>Xyris ambigua</i> | XYAM | OBL |
| <i>Xyris baldwiniana</i> | XYBA | OBL |
| <i>Zizanius glaberrimus</i> | ZIGL | FACW |

^aScientific names for species follow nomenclature of the National Wetland Plant List (Reed 1986) and Godfrey and Wooten (1979,1981).

^bCodes are 4-6 characters assigned to species in the National Wetland Plant List (Reed 1986).

^cIndices for species are as follows: OBL=obligate species, FACW=facultative wetland species, FAC=facultative species, FACU=facultative upland species, and UPL=upland species; indices were assigned to species in the National Wetland Plant List except where noted otherwise (see Table 2 for criteria of ecological indices).

^dAsterisks (*) indicate that the index was assigned to the species following consultations with the National Ecology Research Center.

^ePound signs (#) indicate that the index was assigned to the species following consultations with Mississippi State University botanists.

APPENDIX C

FREQUENCIES OF OCCURRENCE OF SPECIES BY SOIL SERIES WITHIN VEGETATION STRATA

GROUND COVER STRATUM: ATMORE SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| RHCH3 | 311 | 10.3 | 311 | 10.3 |
| SCRE | 311 | 10.3 | 622 | 20.6 |
| CTAR | 300 | 9.9 | 922 | 30.5 |
| DIAC2 | 215 | 7.1 | 1137 | 37.6 |
| RHOL | 121 | 4.0 | 1258 | 41.6 |
| HEHE4 | 114 | 3.8 | 1372 | 45.3 |
| ANRU | 99 | 3.3 | 1471 | 48.6 |
| ERCO7 | 90 | 3.0 | 1561 | 51.6 |
| DIDI6 | 86 | 2.8 | 1647 | 54.4 |
| SAAL4 | 86 | 2.8 | 1733 | 57.3 |
| XYAM | 85 | 2.8 | 1818 | 60.1 |
| ILGL | 82 | 2.7 | 1900 | 62.8 |
| LACA5 | 81 | 2.7 | 1981 | 65.5 |
| CAPS5 | 65 | 2.1 | 2046 | 67.6 |
| DRCA2 | 59 | 1.9 | 2105 | 69.6 |
| BAUN | 58 | 1.9 | 2163 | 71.5 |
| LOAM3 | 52 | 1.7 | 2215 | 73.2 |
| BINU | 48 | 1.6 | 2263 | 74.8 |
| ALLU | 47 | 1.6 | 2310 | 76.3 |
| ERDE5 | 47 | 1.6 | 2357 | 77.9 |
| LYAL2 | 47 | 1.6 | 2404 | 79.4 |
| MUEX | 47 | 1.6 | 2451 | 81.0 |
| SMLA | 41 | 1.4 | 2492 | 82.4 |
| SCSC | 40 | 1.3 | 2532 | 83.7 |
| RHAL4 | 38 | 1.3 | 2570 | 84.9 |
| SAPS2 | 38 | 1.3 | 2608 | 86.2 |
| SPHAG | 38 | 1.3 | 2646 | 87.4 |
| CEAS | 26 | 0.9 | 2672 | 88.3 |
| COLI5 | 26 | 0.9 | 2698 | 89.2 |
| ARAF | 24 | 0.8 | 2722 | 90.0 |
| LYCA3 | 23 | 0.8 | 2745 | 90.7 |
| XYBA | 22 | 0.7 | 2767 | 91.4 |
| JUNCU | 21 | 0.7 | 2788 | 92.1 |
| RHGR | 20 | 0.7 | 2808 | 92.8 |
| RHLU | 20 | 0.7 | 2828 | 93.5 |
| RHPL3 | 18 | 0.6 | 2846 | 94.1 |
| ASST2 | 16 | 0.5 | 2862 | 94.6 |
| DILA2 | 16 | 0.5 | 2878 | 95.1 |
| BAVI3 | 15 | 0.5 | 2893 | 95.6 |
| LOBR3 | 12 | 0.4 | 2905 | 96.0 |
| BUCA3 | 11 | 0.4 | 2916 | 96.4 |
| CHTO | 11 | 0.4 | 2927 | 96.7 |
| HYBR3 | 10 | 0.3 | 2937 | 97.1 |

(Continued)

GROUND COVER STRATUM: ATMORE SERIES
(Concluded)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| RHYNC | 10 | 0.3 | 2947 | 97.4 |
| UTJU | 10 | 0.3 | 2957 | 97.7 |
| PALO | 7 | 0.2 | 2964 | 98.0 |
| AGAP3 | 5 | 0.2 | 2969 | 98.1 |
| LISP | 5 | 0.2 | 2974 | 98.3 |
| SCBA2 | 5 | 0.2 | 2979 | 98.4 |
| ZIGL | 5 | 0.2 | 2984 | 98.6 |
| FUBR | 4 | 0.1 | 2988 | 98.7 |
| MYHE | 4 | 0.1 | 2992 | 98.9 |
| RHPE | 4 | 0.1 | 2996 | 99.0 |
| TORA | 4 | 0.1 | 3000 | 99.1 |
| DICRA | 3 | 0.1 | 3003 | 99.2 |
| EULE | 3 | 0.1 | 3006 | 99.3 |
| POLU | 3 | 0.1 | 3009 | 99.4 |
| ERIN6 | 2 | 0.1 | 3011 | 99.5 |
| ERRE | 2 | 0.1 | 3013 | 99.6 |
| LAAN | 2 | 0.1 | 3015 | 99.6 |
| LIME2 | 2 | 0.1 | 3017 | 99.7 |
| AGOB | 1 | 0.0 | 3018 | 99.7 |
| EUMI6 | 1 | 0.0 | 3019 | 99.8 |
| FITO | 1 | 0.0 | 3020 | 99.8 |
| HYRI2 | 1 | 0.0 | 3021 | 99.8 |
| MYCE | 1 | 0.0 | 3022 | 99.9 |
| PIEL | 1 | 0.0 | 3023 | 99.9 |
| RHFA | 1 | 0.0 | 3024 | 99.9 |
| SACA26 | 1 | 0.0 | 3025 | 100.0 |
| SCLER | 1 | 0.0 | 3026 | 100.0 |

GROUND COVER STRATUM: CROATAN SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| SPHAG | 253 | 25.9 | 253 | 25.9 |
| ERDE5 | 131 | 13.4 | 384 | 39.3 |
| RHCO2 | 108 | 11.1 | 492 | 50.4 |
| RHYNC | 94 | 9.6 | 586 | 60.0 |
| CAGL5 | 70 | 7.2 | 656 | 67.1 |
| XYAM | 41 | 4.2 | 697 | 71.3 |

(Continued)

GROUND COVER STRATUM: CROATAN SERIES
(Concluded)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| RHCE | 32 | 3.3 | 729 | 74.6 |
| DISC2 | 28 | 2.9 | 757 | 77.5 |
| PAVI2 | 27 | 2.8 | 784 | 80.2 |
| SCSC | 27 | 2.8 | 811 | 83.0 |
| SMLA | 22 | 2.3 | 833 | 85.3 |
| POCY | 19 | 1.9 | 852 | 87.2 |
| ACRU | 13 | 1.3 | 865 | 88.5 |
| PALO | 10 | 1.0 | 875 | 89.6 |
| BICA | 8 | 0.8 | 883 | 90.4 |
| ERCO7 | 8 | 0.8 | 891 | 91.2 |
| GAMO3 | 8 | 0.8 | 899 | 92.0 |
| LACA5 | 8 | 0.8 | 907 | 92.8 |
| COTR4 | 7 | 0.7 | 914 | 93.6 |
| CYRA | 7 | 0.7 | 921 | 94.3 |
| RHCH3 | 6 | 0.6 | 927 | 94.9 |
| RHGR | 6 | 0.6 | 933 | 95.5 |
| DRCA2 | 5 | 0.5 | 938 | 96.0 |
| ILGL | 5 | 0.5 | 943 | 96.5 |
| TADI2 | 5 | 0.5 | 948 | 97.0 |
| LOFL3 | 4 | 0.4 | 952 | 97.4 |
| NYSY | 4 | 0.4 | 956 | 97.9 |
| XYBA | 4 | 0.4 | 960 | 98.3 |
| ANRU | 2 | 0.2 | 962 | 98.5 |
| ASST2 | 2 | 0.2 | 964 | 98.7 |
| DICRA | 2 | 0.2 | 966 | 98.9 |
| HYBR3 | 2 | 0.2 | 968 | 99.1 |
| LYVI | 2 | 0.2 | 970 | 99.3 |
| PAVE2 | 2 | 0.2 | 972 | 99.5 |
| ERVE | 1 | 0.1 | 973 | 99.6 |
| JUDI | 1 | 0.1 | 974 | 99.7 |
| OXFI | 1 | 0.1 | 975 | 99.8 |
| QUNI | 1 | 0.1 | 976 | 99.9 |
| SCLER | 1 | 0.1 | 977 | 100.0 |

GROUND COVER STRATUM: HYDE SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ARST5 | 363 | 13.9 | 363 | 13.9 |
| DIAC2 | 180 | 6.9 | 543 | 20.8 |
| SCRE | 149 | 5.7 | 692 | 26.5 |
| RHCH3 | 141 | 5.4 | 833 | 31.9 |
| ILGL | 134 | 5.1 | 967 | 37.0 |
| DISC2 | 119 | 4.6 | 1086 | 41.5 |
| CTAR | 98 | 3.7 | 1184 | 45.3 |
| HEHE4 | 86 | 3.3 | 1270 | 48.6 |
| DID16 | 76 | 2.9 | 1346 | 51.5 |
| SCSC | 75 | 2.9 | 1421 | 54.4 |
| SPHAG | 72 | 2.8 | 1493 | 57.1 |
| RHPL3 | 63 | 2.4 | 1556 | 59.5 |
| CAPS5 | 61 | 2.3 | 1617 | 61.9 |
| MUEX | 52 | 2.0 | 1669 | 63.8 |
| RHYNC | 52 | 2.0 | 1721 | 65.8 |
| ERDE5 | 46 | 1.8 | 1767 | 67.6 |
| BAUN | 44 | 1.7 | 1811 | 69.3 |
| PAVI2 | 43 | 1.6 | 1854 | 70.9 |
| RHOL | 40 | 1.5 | 1894 | 72.5 |
| XYAM | 40 | 1.5 | 1934 | 74.0 |
| ERVE | 38 | 1.5 | 1972 | 75.4 |
| RHAL4 | 37 | 1.4 | 2009 | 76.9 |
| ARAF | 36 | 1.4 | 2045 | 78.2 |
| ASST2 | 33 | 1.3 | 2078 | 79.5 |
| ERCO7 | 31 | 1.2 | 2109 | 80.7 |
| ANRU | 29 | 1.1 | 2138 | 81.8 |
| EULE | 29 | 1.1 | 2167 | 82.9 |
| COLI5 | 28 | 1.1 | 2195 | 84.0 |
| SAAL4 | 25 | 1.0 | 2220 | 84.9 |
| ARGI | 23 | 0.9 | 2243 | 85.8 |
| ASDU | 20 | 0.8 | 2263 | 86.6 |
| HYBR3 | 20 | 0.8 | 2283 | 87.3 |
| DRCA2 | 19 | 0.7 | 2302 | 88.1 |
| SCBA2 | 18 | 0.7 | 2320 | 88.8 |
| JUNCU | 16 | 0.6 | 2336 | 89.4 |
| LACA5 | 16 | 0.6 | 2352 | 90.0 |
| LOBR3 | 16 | 0.6 | 2368 | 90.6 |
| PALLA | 14 | 0.5 | 2382 | 91.1 |
| PAVE2 | 14 | 0.5 | 2396 | 91.7 |
| CEAS | 13 | 0.5 | 2409 | 92.2 |
| RHGR | 12 | 0.5 | 2421 | 92.6 |
| CHTO | 11 | 0.4 | 2432 | 93.0 |
| MYHE | 11 | 0.4 | 2443 | 93.5 |

(Continued)

GROUND COVER STRATUM: HYDE SERIES
(Continued)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| COTR4 | 9 | 0.3 | 2452 | 93.8 |
| ALLU | 8 | 0.3 | 2460 | 94.1 |
| BINU | 8 | 0.3 | 2468 | 94.4 |
| LOFL3 | 8 | 0.3 | 2476 | 94.7 |
| MYCE | 8 | 0.3 | 2484 | 95.0 |
| SCLER | 8 | 0.3 | 2492 | 95.3 |
| SMLA | 8 | 0.3 | 2500 | 95.6 |
| ANMO3 | 7 | 0.3 | 2507 | 95.9 |
| EUMI6 | 6 | 0.2 | 2513 | 96.1 |
| GAMO3 | 6 | 0.2 | 2519 | 96.4 |
| LISP | 6 | 0.2 | 2525 | 96.6 |
| LOAM3 | 6 | 0.2 | 2531 | 96.8 |
| LYAL2 | 6 | 0.2 | 2537 | 97.1 |
| PALO | 6 | 0.2 | 2543 | 97.3 |
| ACRU | 5 | 0.2 | 2548 | 97.5 |
| BAVI3 | 5 | 0.2 | 2553 | 97.7 |
| LULI | 5 | 0.2 | 2558 | 97.9 |
| EUSE | 4 | 0.2 | 2562 | 98.0 |
| SACA26 | 4 | 0.2 | 2566 | 98.2 |
| UTJU | 4 | 0.2 | 2570 | 98.3 |
| AGAP3 | 3 | 0.1 | 2573 | 98.4 |
| DILE3 | 3 | 0.1 | 2576 | 98.5 |
| ILCO | 3 | 0.1 | 2579 | 98.7 |
| RHLU | 3 | 0.1 | 2582 | 98.8 |
| XYBA | 3 | 0.1 | 2585 | 98.9 |
| CLAL3 | 2 | 0.1 | 2587 | 99.0 |
| DIVI3 | 2 | 0.1 | 2589 | 99.0 |
| ERIN6 | 2 | 0.1 | 2591 | 99.1 |
| ILMY | 2 | 0.1 | 2593 | 99.2 |
| POLU | 2 | 0.1 | 2595 | 99.3 |
| RHBA | 2 | 0.1 | 2597 | 99.3 |
| ASCLE | 1 | 0.0 | 2598 | 99.4 |
| ASLO | 1 | 0.0 | 2599 | 99.4 |
| AXAF | 1 | 0.0 | 2600 | 99.5 |
| CYSE | 1 | 0.0 | 2601 | 99.5 |
| DILA2 | 1 | 0.0 | 2602 | 99.5 |
| ERRE | 1 | 0.0 | 2603 | 99.6 |
| FUBR | 1 | 0.0 | 2604 | 99.6 |
| HYCI | 1 | 0.0 | 2605 | 99.7 |
| LAAN | 1 | 0.0 | 2606 | 99.7 |
| LIME2 | 1 | 0.0 | 2607 | 99.7 |
| MAVI2 | 1 | 0.0 | 2608 | 99.8 |

(Continued)

GROUND COVER STRATUM: HYDE SERIES
(Concluded)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| OXFI | 1 | 0.0 | 2609 | 99.8 |
| PIEL | 1 | 0.0 | 2610 | 99.8 |
| PLIN5 | 1 | 0.0 | 2611 | 99.9 |
| POCR | 1 | 0.0 | 2612 | 99.9 |
| RHPE | 1 | 0.0 | 2613 | 100.0 |
| VILA4 | 1 | 0.0 | 2614 | 100.0 |

GROUND COVER STRATUM: PLUMMER SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| RHCH3 | 411 | 13.6 | 411 | 13.6 |
| CTAR | 306 | 10.2 | 717 | 23.8 |
| ARST5 | 236 | 7.8 | 953 | 31.6 |
| DIAC2 | 166 | 5.5 | 1119 | 37.1 |
| SAAL4 | 131 | 4.3 | 1250 | 41.5 |
| HYBR3 | 112 | 3.7 | 1362 | 45.2 |
| ILGL | 107 | 3.6 | 1469 | 48.8 |
| HEHE4 | 99 | 3.3 | 1568 | 52.0 |
| ERCO7 | 85 | 2.8 | 1653 | 54.9 |
| SCRE | 75 | 2.5 | 1728 | 57.4 |
| ANRU | 69 | 2.3 | 1797 | 59.6 |
| MUEX | 68 | 2.3 | 1865 | 61.9 |
| LACA5 | 67 | 2.2 | 1932 | 64.1 |
| XYAM | 66 | 2.2 | 1998 | 66.3 |
| SCSC | 62 | 2.1 | 2060 | 68.4 |
| LOAM3 | 57 | 1.9 | 2117 | 70.3 |
| DIDI6 | 56 | 1.9 | 2173 | 72.1 |
| BAUN | 55 | 1.8 | 2228 | 73.9 |
| LYAL2 | 54 | 1.8 | 2282 | 75.7 |
| RHAL4 | 53 | 1.8 | 2335 | 77.5 |
| RHLU | 53 | 1.8 | 2388 | 79.3 |
| CAPS5 | 50 | 1.7 | 2438 | 80.9 |
| ERDE5 | 47 | 1.6 | 2485 | 82.5 |
| SMLA | 41 | 1.4 | 2526 | 83.8 |
| GAMO3 | 35 | 1.2 | 2561 | 85.0 |
| COLI5 | 32 | 1.1 | 2593 | 86.1 |
| DRCA2 | 32 | 1.1 | 2625 | 87.1 |

(Continued)

GROUND COVER STRATUM: PLUMMER SERIES
(Concluded)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| LAAN | 28 | 0.9 | 2653 | 88.1 |
| SPHAG | 27 | 0.9 | 2680 | 88.9 |
| LYCA3 | 26 | 0.9 | 2706 | 89.8 |
| ALLU | 24 | 0.8 | 2730 | 90.6 |
| ARAF | 23 | 0.8 | 2753 | 91.4 |
| XYBA | 23 | 0.8 | 2776 | 92.1 |
| BINU | 21 | 0.7 | 2797 | 92.8 |
| ILCO | 21 | 0.7 | 2818 | 93.5 |
| RHPL3 | 20 | 0.7 | 2838 | 94.2 |
| LOBR3 | 19 | 0.6 | 2857 | 94.8 |
| CHTO | 14 | 0.5 | 2871 | 95.3 |
| ASST2 | 13 | 0.4 | 2884 | 95.7 |
| PIEL | 13 | 0.4 | 2897 | 96.2 |
| BAVI3 | 11 | 0.4 | 2908 | 96.5 |
| RHYNC | 11 | 0.4 | 2919 | 96.9 |
| SAPS2 | 10 | 0.3 | 2929 | 97.2 |
| PAVI2 | 9 | 0.3 | 2938 | 97.5 |
| ERRE | 8 | 0.3 | 2946 | 97.8 |
| POLU | 8 | 0.3 | 2954 | 98.0 |
| DILE3 | 6 | 0.2 | 2960 | 98.2 |
| RHGR | 6 | 0.2 | 2966 | 98.4 |
| CEAS | 5 | 0.2 | 2971 | 98.6 |
| DICRA | 5 | 0.2 | 2976 | 98.8 |
| RHOL | 5 | 0.2 | 2981 | 98.9 |
| MYCE | 4 | 0.1 | 2985 | 99.1 |
| ANMO3 | 3 | 0.1 | 2988 | 99.2 |
| FUBR | 3 | 0.1 | 2991 | 99.3 |
| JUNCU | 3 | 0.1 | 2994 | 99.4 |
| BUCA3 | 2 | 0.1 | 2996 | 99.4 |
| SCBA2 | 2 | 0.1 | 2998 | 99.5 |
| TORA | 2 | 0.1 | 3000 | 99.6 |
| ACRU | 1 | 0.0 | 3001 | 99.6 |
| AGAP3 | 1 | 0.0 | 3002 | 99.6 |
| CYSE | 1 | 0.0 | 3003 | 99.7 |
| DRFI | 1 | 0.0 | 3005 | 99.7 |
| ERVE | 1 | 0.0 | 3006 | 99.8 |
| FITO | 1 | 0.0 | 3007 | 99.8 |
| JUMA4 | 1 | 0.0 | 3008 | 99.8 |
| LIME2 | 1 | 0.0 | 3009 | 99.9 |
| MYRIC | 1 | 0.0 | 3010 | 99.9 |
| RHFI | 1 | 0.0 | 3011 | 99.9 |
| RHPE | 1 | 0.0 | 3012 | 100.0 |
| UTJU | 1 | 0.0 | 3013 | 100.0 |

GROUND COVER STRATUM: HARLESTON SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ARST5 | 390 | 22.2 | 390 | 22.2 |
| PAVE2 | 141 | 8.0 | 531 | 30.2 |
| ILCO | 127 | 7.2 | 658 | 37.5 |
| ILGL | 111 | 6.3 | 769 | 43.8 |
| DIIS | 95 | 5.4 | 864 | 49.2 |
| LACA5 | 72 | 4.1 | 936 | 53.3 |
| GAMO3 | 64 | 3.6 | 1000 | 56.9 |
| SMLA | 62 | 3.5 | 1062 | 60.4 |
| EUMI6 | 51 | 2.9 | 1113 | 63.3 |
| SCSC | 48 | 2.7 | 1161 | 66.1 |
| RHCH3 | 32 | 1.8 | 1193 | 67.9 |
| XYAM | 29 | 1.7 | 1222 | 69.6 |
| CTAR | 27 | 1.5 | 1249 | 71.1 |
| SCRE | 26 | 1.5 | 1275 | 72.6 |
| RHAL4 | 25 | 1.4 | 1300 | 74.0 |
| DIAC | 24 | 1.4 | 1324 | 75.4 |
| DIAC2 | 23 | 1.3 | 1347 | 76.7 |
| HEHE4 | 22 | 1.3 | 1369 | 77.9 |
| LAAN | 20 | 1.1 | 1389 | 79.1 |
| MYCE | 20 | 1.1 | 1409 | 80.2 |
| DIVI3 | 17 | 1.0 | 1426 | 81.2 |
| DIDI6 | 16 | 0.9 | 1442 | 82.1 |
| LYAL2 | 16 | 0.9 | 1458 | 83.0 |
| DICI | 15 | 0.9 | 1473 | 83.8 |
| DILE3 | 15 | 0.9 | 1488 | 84.7 |
| EUAN4 | 14 | 0.8 | 1502 | 85.5 |
| LOAM3 | 14 | 0.8 | 1516 | 86.3 |
| RUHI | 13 | 0.7 | 1529 | 87.0 |
| MUEX | 12 | 0.7 | 1541 | 87.7 |
| EUCA5 | 11 | 0.6 | 1552 | 88.3 |
| COCA5 | 10 | 0.6 | 1562 | 88.9 |
| LYCA3 | 10 | 0.6 | 1572 | 89.5 |
| VILA4 | 10 | 0.6 | 1582 | 90.0 |
| WOAR | 10 | 0.6 | 1592 | 90.6 |
| ANRU | 9 | 0.5 | 1601 | 91.1 |
| ERRE | 9 | 0.5 | 1610 | 91.6 |
| ASST2 | 7 | 0.4 | 1617 | 92.0 |
| CYRE5 | 7 | 0.4 | 1624 | 92.4 |
| DRCA2 | 7 | 0.4 | 1631 | 92.8 |
| LUVI2 | 7 | 0.4 | 1638 | 93.2 |
| BAUN | 6 | 0.3 | 1644 | 93.6 |
| BINU | 6 | 0.3 | 1650 | 93.9 |
| EURO4 | 6 | 0.3 | 1656 | 94.3 |

(Continued)

GROUND COVER STRATUM: HARLESTON SERIES
(Continued)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| MAVI2 | 6 | 0.3 | 1662 | 94.6 |
| MYHE | 6 | 0.3 | 1668 | 94.9 |
| OLUN | 6 | 0.3 | 1674 | 95.3 |
| RHPL3 | 6 | 0.3 | 1680 | 95.6 |
| SMBO2 | 6 | 0.3 | 1686 | 96.0 |
| EULE | 5 | 0.3 | 1691 | 96.2 |
| EUPAT | 4 | 0.2 | 1695 | 96.5 |
| POPR4 | 4 | 0.2 | 1699 | 96.7 |
| SCLER | 4 | 0.2 | 1703 | 96.9 |
| FITO | 3 | 0.2 | 1706 | 97.1 |
| NYSY | 3 | 0.2 | 1709 | 97.3 |
| RHRA2 | 3 | 0.2 | 1712 | 97.4 |
| ACRU | 2 | 0.1 | 1714 | 97.6 |
| ANTEN | 2 | 0.1 | 1716 | 97.7 |
| ASDU | 2 | 0.1 | 1718 | 97.8 |
| DICRA | 2 | 0.1 | 1720 | 97.9 |
| HYBR3 | 2 | 0.1 | 1722 | 98.0 |
| LOBR3 | 2 | 0.1 | 1724 | 98.1 |
| PIEL | 2 | 0.1 | 1726 | 98.2 |
| RHFA | 2 | 0.1 | 1728 | 98.3 |
| RHPE | 2 | 0.1 | 1730 | 98.5 |
| RHYNC | 2 | 0.1 | 1732 | 98.6 |
| RUFL | 2 | 0.1 | 1734 | 98.7 |
| AXAF | 1 | 0.1 | 1735 | 98.7 |
| CANI4 | 1 | 0.1 | 1736 | 98.8 |
| CEAS | 1 | 0.1 | 1737 | 98.9 |
| CRPU5 | 1 | 0.1 | 1738 | 98.9 |
| DITE2 | 1 | 0.1 | 1739 | 99.0 |
| ERYU | 1 | 0.1 | 1740 | 99.0 |
| EUCO10 | 1 | 0.1 | 1741 | 99.1 |
| EUCO7 | 1 | 0.1 | 1742 | 99.1 |
| GAPU3 | 1 | 0.1 | 1743 | 99.2 |
| HEGR10 | 1 | 0.1 | 1744 | 99.3 |
| HYGE | 1 | 0.1 | 1745 | 99.3 |
| JUDI | 1 | 0.1 | 1746 | 99.4 |
| LINUM | 1 | 0.1 | 1747 | 99.4 |
| PLFO | 1 | 0.1 | 1748 | 99.5 |
| POLU | 1 | 0.1 | 1749 | 99.5 |
| RHFI | 1 | 0.1 | 1750 | 99.6 |
| RHGR | 1 | 0.1 | 1751 | 99.7 |
| RHLU | 1 | 0.1 | 1752 | 99.7 |
| RHOL | 1 | 0.1 | 1753 | 99.8 |

(Continued)

GROUND COVER STRATUM: HARLESTON SERIES
(Concluded)

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| RHPA | 1 | 0.1 | 1754 | 99.8 |
| RHPU3 | 1 | 0.1 | 1755 | 99.9 |
| SCBA2 | 1 | 0.1 | 1756 | 99.9 |
| TRSM | 1 | 0.1 | 1757 | 100.0 |

SMALL SHRUB STRATUM: ATMORE SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| ILGL | 34 | 100.0 | 34 | 100.0 |

SMALL SHRUB STRATUM: CROATAN SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|-------------------------|-----------------------|
| LYLU3 | 6 | 27.3 | 6 | 27.3 |
| CYRA | 4 | 18.2 | 10 | 45.5 |
| HYBR3 | 4 | 18.2 | 14 | 63.6 |
| ACRU | 3 | 13.6 | 17 | 77.3 |
| ILGL | 3 | 13.6 | 20 | 90.9 |
| CLAL3 | 1 | 4.5 | 21 | 95.5 |
| SMLA | 1 | 4.5 | 22 | 100.0 |

SMALL SHRUB STRATUM: HYDE SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILGL | 166 | 83.4 | 166 | 83.4 |
| MYCE | 14 | 7.0 | 180 | 90.5 |
| ASST2 | 5 | 2.5 | 185 | 93.0 |
| HYBR3 | 5 | 2.5 | 190 | 95.5 |
| SMLA | 5 | 2.5 | 195 | 98.0 |
| ILMY | 3 | 1.5 | 198 | 99.5 |
| PIEL | 1 | 0.5 | 199 | 100.0 |

SMALL SHRUB STRATUM: PLUMMER SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILGL | 138 | 71.9 | 138 | 71.9 |
| HYBR3 | 33 | 17.2 | 171 | 89.1 |
| ILCO | 8 | 4.2 | 179 | 93.2 |
| MAVI2 | 4 | 2.1 | 183 | 95.3 |
| SMLA | 4 | 2.1 | 187 | 97.4 |
| MYCE | 3 | 1.6 | 190 | 99.0 |
| GAMO3 | 1 | 0.5 | 191 | 99.5 |
| PIEL | 1 | 0.5 | 192 | 100.0 |

SMALL SHRUB STRATUM: HARLESTON SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILGL | 103 | 55.1 | 103 | 55.1 |
| ILCO | 66 | 35.3 | 169 | 90.4 |
| MAVI2 | 10 | 5.3 | 179 | 95.7 |
| GAMO3 | 3 | 1.6 | 182 | 97.3 |
| RUHI | 2 | 1.1 | 184 | 98.4 |
| ILMY | 1 | 0.5 | 185 | 98.9 |
| NYSY | 1 | 0.5 | 186 | 99.5 |
| SMLA | 1 | 0.5 | 187 | 100.0 |

LARGE SHRUB STRATUM: CROATAN SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILCO | 2 | 100.0 | 2 | 100.0 |

LARGE SHRUB STRATUM: PLUMMER SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILCO | 6 | 100.0 | 6 | 100.0 |

LARGE SHRUB STRATUM: HARLESTON SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| ILGL | 13 | 54.2 | 13 | 54.2 |
| ILCO | 11 | 45.8 | 24 | 100.0 |

TREE STRATUM: CROATAN SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| TADI2 | 11465 | 54.8 | 11465 | 54.8 |
| NYSY | 5583 | 26.7 | 17048 | 81.5 |
| CYRA | 1935 | 9.3 | 18983 | 90.8 |
| PIEL | 1293 | 6.2 | 20276 | 97.0 |
| ACRU | 332 | 1.6 | 20608 | 98.6 |
| PIPA2 | 252 | 1.2 | 20860 | 99.8 |
| MAVI2 | 26 | 0.1 | 20886 | 99.9 |
| QUNI | 11 | 0.1 | 20897 | 100.0 |
| MYCE | 8 | 0.0 | 20905 | 100.0 |

TREE STRATUM: HYDE SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| PIEL | 1443 | 98.4 | 1443 | 98.4 |
| MAGR4 | 24 | 1.6 | 1467 | 100.0 |

TREE STRATUM: PLUMMER SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| PIEL | 767 | 55.4 | 767 | 55.4 |
| PIPA2 | 617 | 44.6 | 1384 | 100.0 |

TREE STRATUM: HARLESTON SERIES

| CODE ^a | Frequency ^b | Percent | Cumulative frequency | Cumulative percent |
|-------------------|------------------------|---------|----------------------|--------------------|
| PIEL | 2825 | 91.5 | 2825 | 91.5 |
| NYSY | 176 | 5.7 | 3001 | 97.2 |
| ILGL | 87 | 2.8 | 3088 | 100.0 |

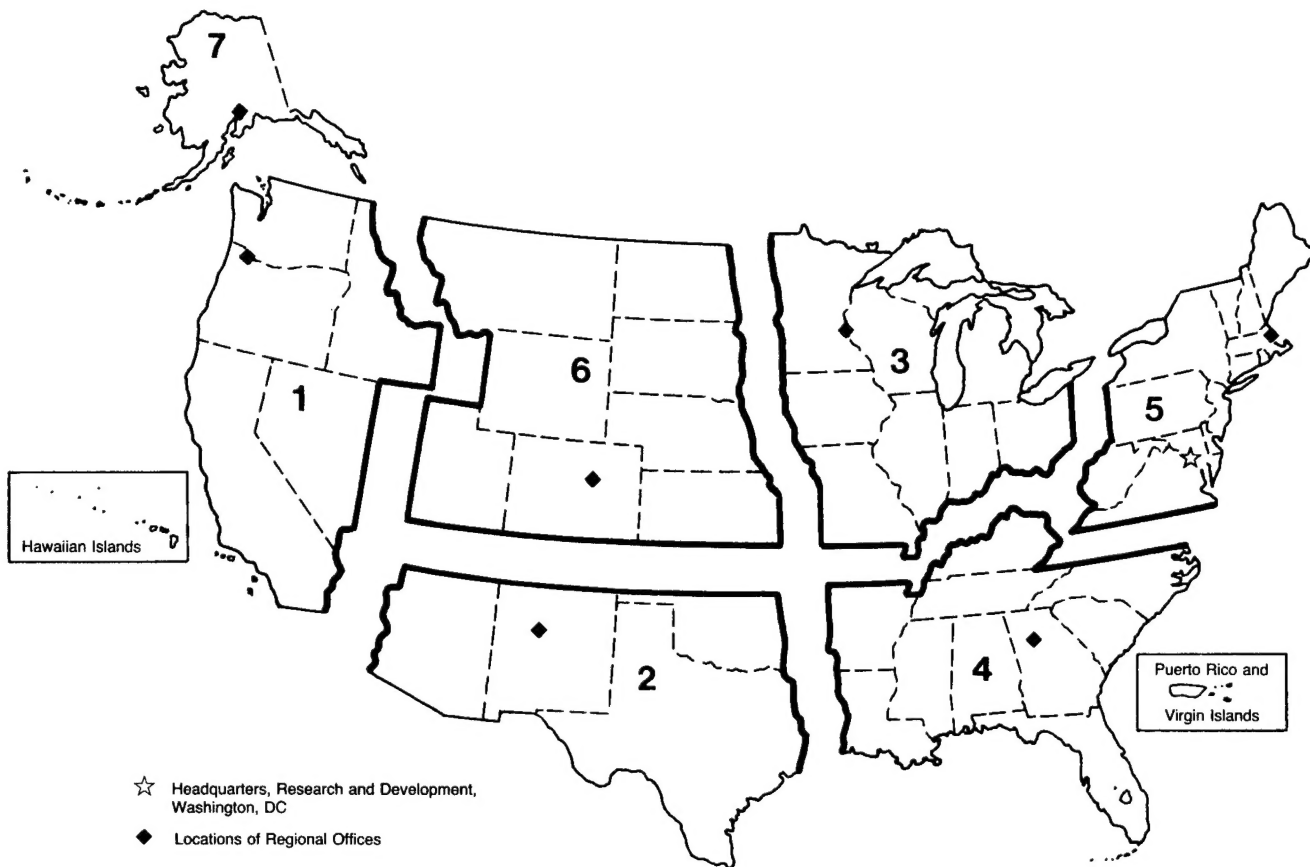
^aCodes for species correspond to those given in Appendix B.

^bFrequencies are weighted by relative abundance of individual species within the vegetation strata.

| | | | |
|--|---|--|-------------------------------------|
| REPORT DOCUMENTATION PAGE | 1. REPORT NO. Biological Report 89(3) | 2. | 3. Recipient's Accession No. |
| 4. Title and Subtitle Soil-Vegetation Correlations in Coastal Mississippi Wetlands | | 5. Report Date November 1989 | |
| 7. Author(s) N.E. Erickson and D.M. Leslie, Jr. | | 8. Performing Organization Rept. No. | |
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| 15. Supplementary Notes | | 14. | |
| 16. Abstract (Limit: 200 words) As part of a national study, vegetation associated with known hydric soil series was sampled on the Mississippi Sandhill Crane National Wildlife Refuge in southern Mississippi. Weighted average values were calculated for vegetation associations on each soil series sampled using the technique developed for the Fish and Wildlife Service by Dr. T.R. Wentworth and G.P. Johnson, North Carolina State University. Good correlations were observed between soils on the Soil Conservation Service's hydric soils list and hydrophytic vegetation identified in the National Wetland Plant List (1986) developed by the Fish and Wildlife Service. However, one soil not on the list supported hydrophytic vegetation. | | | |
| 17. Document Analysis a. Descriptors Wetland soils Wetland plants Hydric soils Hydrophytic vegetation b. Identifiers/Open-Ended Terms Mississippi wetlands Coastal plain wetlands Palustrine wetlands c. COSATI Field/Group | | | |
| 18. Availability Statement Unlimited | | 19. Security Class (This Report) Unclassified | 21. No. of Pages 48 |
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(See ANSI-Z39.18)

See Instructions on Reverse



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Preserve Our Natural Resources



DEPARTMENT OF THE INTERIOR
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